

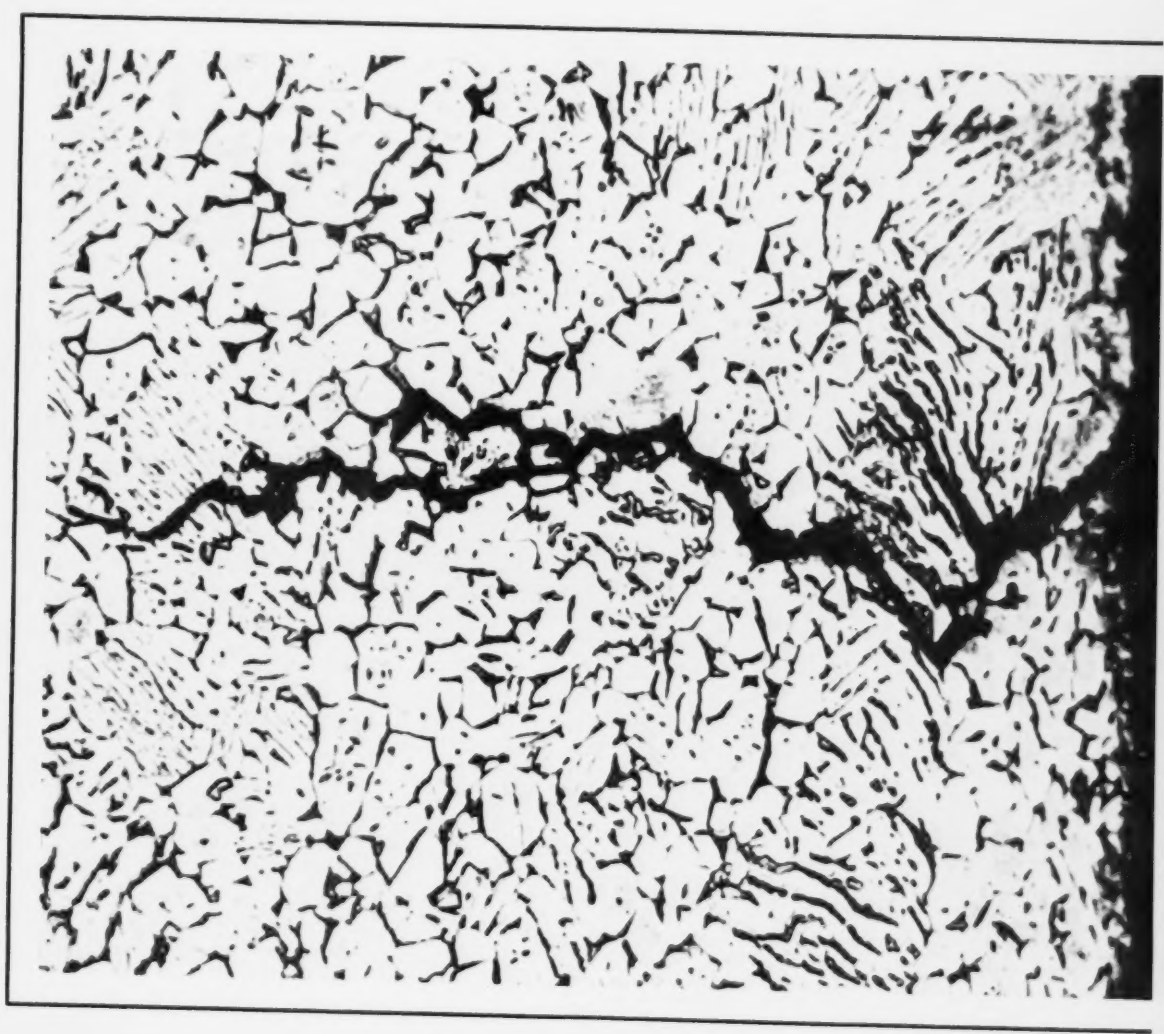
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NATIONAL BUREAU OF STANDARDS *September/1967*

# Technical News Bulletin

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U.S. DEPARTMENT OF COMMERCE

# NATIONAL BUREAU OF STANDARDS

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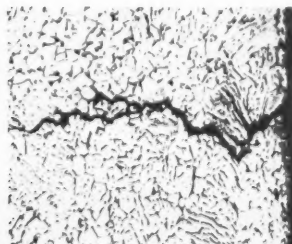


U.S. DEPARTMENT OF COMMERCE  
Alexander B. Trowbridge  
Secretary

NATIONAL BUREAU OF STANDARDS  
A. V. Astin, Director

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## COVER

*Photomicrograph shows that stress-corrosion cracking in a titanium alloy follows grain boundaries. NBS studied this problem for NASA to learn more about this alloy which has been proposed for use in supersonic transports. (See page 200).*

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The National Bureau of Standards serves as a focal point in the Federal Government for assuring maximum application of the physical and engineering sciences to the advancement of technology in industry and commerce. For this purpose, the Bureau is organized into three institutes—

- The Institute for Basic Standards
- The Institute for Materials Research
- The Institute for Applied Technology

The TECHNICAL NEWS BULLETIN is published to keep science and industry informed regarding the technical programs, accomplishments, and activities of all three institutes.

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*P. M. Gruzensky inspects calcite crystals being synthetically produced on the sides of the beaker.*

## TECHNIQUE DEvised TO GROW CALCITE CRYSTALS

■ Calcite single crystals of high purity and with edge lengths of 3 to 4 mm have been produced in the laboratory by P. M. Gruzensky at the NBS Institute for Basic Standards, Boulder Laboratories.<sup>1</sup> It is believed that these are the largest calcite crystals yet produced by the reaction of two compounds in an aqueous solution without diffusion through silica gel.

Production of single crystals of calcite (calcium carbonate) will be valuable for x-ray diffraction calibrations in which calcite is a standard material. If still larger crystals can be developed, they could be useful in laser applications in which calcite might be a suitable host crystal.

Optical-quality calcite several centimeters along an edge can be found in nature, but the supply of the natural material is being gradually depleted. Furthermore, no control of the impurity concentration is pos-

sible in the natural crystal; yet many experiments (such as electron paramagnetic resonance) depend on crystals with controlled impurity concentrations. Thus, synthetic production of calcite has been a subject of study for many years.

Because of its chemical properties, however, calcite cannot be easily grown by the ordinary crystal growth methods. Growth from a melt is precluded because at ordinary pressures calcite decomposes before its melting point is reached, so that extremely high pressures have to be considered. Its solubility in water is so low that growth from a pure aqueous solution is also not practical.

Previous calcite crystal growth efforts have relied on physical or chemical modification of a solvent to increase the calcite's solubility, or on the careful control of the rate of chemical reaction in which calcite is a

product. Some investigations also have been concerned with establishing the conditions under which various crystallographic forms are obtained, or with the kinetics of specific reactions that produce calcite—the production of large crystals being of secondary interest.

In the present study, the solubility of calcite in water was increased by the addition of ammonium salts such as ammonium chloride. Also, a slow precipitation rate favored the formation of calcite, since the greater the precipitation rate, the greater is the tendency to form metastable states of calcium carbonate. Calcite is the crystallographic form of calcium carbonate that is thermodynamically stable at room temperature.

To obtain the calcite crystals, solid ammonium carbonate was placed in a glass container, which was covered except for a hole 5 mm in diameter.

*continued*  
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## CALCITE CRYSTALS *continued*

The container was suspended in a large covered beaker above 2 liters of an aqueous solution containing calcium chloride and ammonium chloride. The low vapor pressure of solid ammonium carbonate at room temperature caused vapor diffusion through the 5 mm hole to the solution. A reaction took place with the calcium chloride giving crystalline calcium carbonate and ammonium chloride as the end products. The calcium carbonate was deposited as transparent calcite rhombs on the beaker walls, some with edge dimensions of 3 to 4 mm. Comparison of the lattice spacing  $d$ -values, obtained from x-ray diffraction measurements with known  $d$ -values of calcite, verified that these crystals were calcite.

Unless the starting concentrations were held to prescribed limits, the reaction took place at the solution surface, forming a crust and preventing growth of any sizeable crystals. For best results it was found that the calcium chloride concentration should not exceed 2 weight percent, while the ammonium chloride concentration should be at least 20 weight percent. Transport of ammonium carbonate vapor to the solution took place at a rate such that the reaction was completed in 3 weeks. This corresponded to the deposition of approximately 20 micrograms of calcium carbonate per second.

An important step in the procedure was the removal of impurities from the calcium chloride-ammonium chloride solution by filtration through a membrane filter having a nominal pore diameter of 10  $\mu$ . Atmospheric dust, colloidal particles, and other foreign material are extremely effective in nucleating supersaturated solutions. It was therefore imperative that such extraneous matter be removed to the greatest extent possible by ultra filtration techniques.

<sup>1</sup> For further details, see Growth of calcite crystals, by P. M. Gruzensky, *J. Phys. Chem. Solids* 28, 365-367 (Feb. 1967).

## BOULDER SCIENTISTS FIND

# NUCLEAR HEXADECAPOLE TRANSITIONS

■ Knowledge of the inner processes of the atom has been furthered by a team of scientists working at the Bureau. R. J. Mahler and L. W. James of the NBS Radio Standards Laboratory (Boulder, Colo.) and W. H. Tanttla of the University of Colorado have experimentally verified in indium previously predicted nuclear hexadecapole transitions.<sup>1</sup> As a result of this experiment, scientists have found nuclear interactions that can be used to measure new nuclear physical parameters.

A hexadecapole consists of 16 poles arranged in one, two, or three dimensions. In a nucleus the electrical hexadecapole is simulated by three-dimensional charge distributions such that if these charges were all on a surface, the surface would resemble a football with a tight belt about its middle. The electrical hexadecapole moment gives a measure of this distribution and is determined by observing transitions between different energy states of the nucleus. These transitions occur by the emission or absorption of phonons (sound waves).

In this study the nuclear electric hexadecapole transitions were observed in indium nuclei embedded in an indium-arsenide crystal. The crystal was placed in an external magnetic field, which split the existing nuclear energy states into separate states. The nuclear distribution between the energy levels were then determined by pulsed nuclear magnetic resonance, and the hexadecapole transitions were detected by noting the changes in this distribution when phonons of varying frequencies were added to the crystal.

The observation of these nuclear transitions experimentally proved the existence of hexadecapole moments in nuclei. For indium, this moment was estimated to be  $10^{-17}$  (cm)<sup>4</sup>, an extremely small quantity which required very sensitive detection methods.

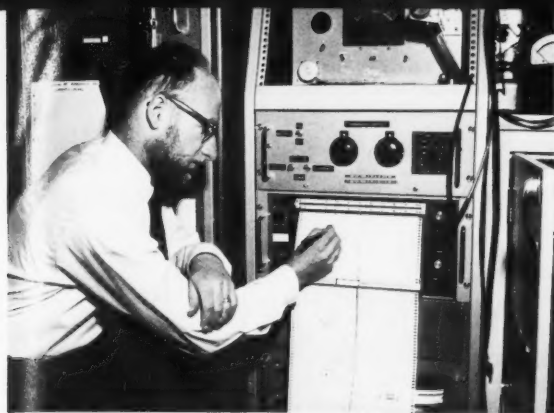
<sup>1</sup> For further technical details, see Possible observation of  $\text{In}^{115}$  nuclear electric hexadecapole transitions, by R. J. Mahler, L. W. James, and W. H. Tanttla, *Phys. Rev. Letters* 16, 259-261 (1966).

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*Sidney B. Lang records data on equipment designed and developed at NBS to study the pyroelectric effect at cryogenic temperatures.*

## **PYROELECTRIC CERAMICS FOR MEASURING LOW TEMPERATURE**

■ A recent study at the NBS Institute for Materials Research investigated the feasibility of using pyroelectric materials as thermometer sensors to measure minute temperature changes in the cryogenic region. Pyroelectric materials are asymmetrical crystals that become polarized by changes in temperature.

This experimental study of pyroelectric thermometry was partially supported by the National Aeronautics and Space Administration. Under the direction of Sidney B. Lang<sup>1</sup> of the Bureau's Cryogenic Division, the pyroelectric effect in three polarized ceramic materials was investigated.

The phenomenon of pyroelectricity was first observed in Europe in 1703 by Dutch traders who had acquired tourmaline crystals in Ceylon for gemstones. The traders noticed that the tourmaline, when placed in a fire, first attracted ashes and then repelled them.

Since that time, scientific research has revealed that pyroelectric crystals can be regarded as having a built-in or permanent electric polarization. When such a crystal is held at constant temperature, this polarization is not evident. However, when the temperature of the crystal is raised a small amount, the magnitude of the polarization changes. Conversely, if the temperature of the material is lowered by the same amount, the absolute magnitude of the change in polarization is the same, but the direction of the change is reversed. Such research has shown that a thermometer employing such materials as sensors would make possible the measurement of temperature differences smaller than one-millionth of a degree, a limit now unobtainable.

The Bureau's investigation centered about the examination of three types of commercial ceramic materials for use as possible sensing elements. Two of the compounds were principally composed of lead zirconate titanate while the third compound consisted mainly of barium titanate.

Because reliable pyroelectric data in the low-temperature regions is scarce, the investigators were forced to design and develop equipment with which to carry out the study. The equipment was designed to make accurate measurements of the pyroelectric coefficients, dielectric constants, and volume resistivities for all three materials studied, at temperatures ranging from 4 to 425 °K.

Results of this study showed that the barium titanate compound had many phase transitions which would result in an unstable thermometer if it were used as a sensor element. The pyroelectric coefficients of two lead zirconate titanate compounds, however, were found to be reproducible in tests which subjected them to various conditions and environments.

Thus, it was concluded that either of the lead zirconate titanate compounds would make suitable sensors in a pyroelectric thermometer for making accurate, sensitive measurements in the temperature region between 4 and 300 °K. Such a device would be extremely useful in calorimetry or electromagnetic radiation detection where temperature changes of the order of microdegrees must be sensed.

<sup>1</sup> Present address: Lawrence Radiation Laboratory, Refractory Materials Division, Chemistry Department, Livermore, Calif.

## **REMINDER . . . .**

Next month, October 16-19, the Institute for Materials Research will hold its 2d Materials Research Symposium, "Molecular Dynamics and Structure of Solids." A review

of recent progress with emphasis on interdisciplinary cooperation will be provided by invited lectures and contributed papers.

# IMPROVED HIGH-TEMPERATURE DETERMINATION OF THERMAL EMITTANCE

■ One of the problems facing today's space program is that of obtaining reliable thermal emittance measurements of nonmetals at high temperatures. Emittance measurements are essential for determining the heat-transfer and heat-dissipation properties of components used in aircraft, missiles, and spacecraft.

In a recent study, J. C. Richmond, D. L. Kelley, and M. Mulbrandon of the NBS Institute for Basic Standards revealed intolerably large errors in the previously used shallow-cavity method of emittance measurement. This study, sponsored by the Air Force, resulted in the development of two techniques that give higher accuracies in high-temperature emittance determinations.

Thermal emittance measurements at temperatures above 2,000 °K, where standard platinum-base thermocouples cannot be used, have never been satisfactorily achieved. Nonmetals, particularly the ceramic oxides, usually have low thermal conductivity and relatively high thermal emittance, and are translucent to appreciable depths below the surface. These properties make it difficult to measure accurately the temperature of emitting specimens. But, since emittance is defined as the ratio of the flux per unit area emitted by a specimen to that emitted by a blackbody radiator at the same temperature and under the same conditions, accurate measurements of specimen temperature are needed for good results. One method of avoiding this difficulty has been to make the blackbody a shallow cavity that is an integral part of the specimen. In this case the blackbody and specimen are at approximately the same temperature, and emittance meas-

urements can be made by comparison without determining the temperature.

In shallow-cavity emittance measurements the specimen—or the reference cavity—emits vertically to an optical focusing system which directs the flux to a thermocouple detector. By alternately measuring the specimen and reference cavity, a ratio of specimen and reference emittance is obtained.

## Shallow Cavity Measurements

The NBS study has revealed that the shallow cavity is not a good blackbody reference. The method, therefore, is accurate only when the specimen walls are opaque and diffusely reflecting, and when the emittance and temperature of the cavity walls are the same as those at the top of the specimen.

A detailed error analysis of shallow-cavity emittance measurements with a variety of materials showed that in many materials errors arise from scattering, specimen translucency, and thermal gradients. The scattering error can be separated and corrections applied. However, the translucency of some specimens produced errors as large as 60 percent of their emittance values, and thermal gradient errors on the order of 10 percent were found.

In view of the large errors that were found in the shallow-cavity method, two emittance measurements techniques, called the center post and deep cavity methods, were devised. Each method is based on a comparison of the specimen flux to that of reference. In each of the new methods, however, the temperatures of both reference and specimen can be determined.

## Center Post Technique

In the center post technique, a specimen in the form of a thick-walled cylinder is positioned in a tungsten mount which has a center post of the same diameter as the center hole of the specimen. The top of the post is flat and serves as a comparison standard of known emittance. The center post also heats the specimen and so reduces thermal gradients. Thus, if the specimen and the reference standard are at the same temperature, or if corrections are applied to compensate for the temperature difference, accurate emittance measurements may be obtained by comparison.

In this method, some temperature difference ordinarily exists between the reference standard and the specimen. It is possible to correct for this difference, however, because the center post temperature can be determined with

*A. W. Crigler makes emittance measurements on a nonmetal specimen. The specimen (inside heater coils) emits vertically to the optical focusing system and thermocouple detector.*



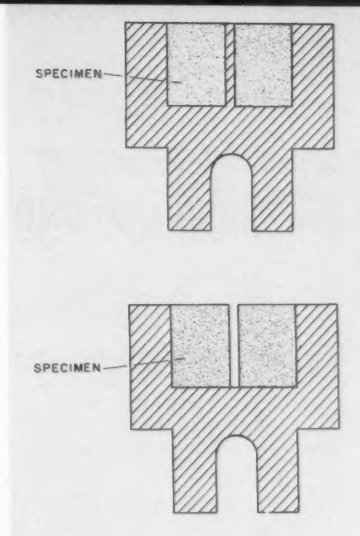
an optical pyrometer. The effective temperature of the specimen can also be determined by a knowledge of its thermal conductivity and extinction coefficient. This involves a great deal of computation; however, the investigators are now in the process of developing a computer program for time-saving reduction in determination of specimen temperature.

### Deep Cavity Technique

The deep cavity method is similar to the center post technique, except that instead of a center post, the center of the cylindrical specimen is used as a deep cavity, providing a reasonable approximation of a true blackbody. In this method the specimen emittance is compared to that of the deep cavity blackbody. If the temperature of the specimen and the reference standard are not the same, corrections must be applied as before.

The deep cavity temperature can be measured with an optical pyrometer because it is a close approximation to a true blackbody. Specimen temperature may be calculated by the same procedure as used in the center post technique. Thus, reasonably accurate emittance measurements may be obtained because corrections can be made for temperature differences.

Both of the improved methods substantially decrease the errors in emittance measurements. The center post



*This drawing illustrates the specimen and mount used in the center post (top) and deep cavity (bottom) methods for measuring thermal emittance of nonconductors at elevated temperatures.*

technique, however, appears to be more precise; its uncertainty of measurement is less than 0.05.

Although these methods have improved the accuracy of emittance measurements, the 0.05 uncertainty is relatively large for some specimens. NBS is now in the process of developing an integrating sphere reflectometer that promises to measure emittance with an uncertainty less than 1 percent.

## COMMITTEES PLAN PRECOORDINATION OF BUILDING COMPONENTS AND SYSTEMS

■ Progress is being made toward the development of criteria for the precoordination of building components and systems. Under the auspices of the United States of America Standards Institute (USASI) Sectional Committee A62, the first working group drafting such standards for the guidance of the building industry met in New York City on April 10, 1967; another group met on April 29, 1967. The purpose of precoordination is to eliminate waste in building construction by preplanning components to assemble into complete systems without losing any design flexibility.

Sectional Committee A62 was recently reactivated under the sponsorship of the Building Research Division of the NBS Institute for Applied Technology.<sup>1</sup> It is to deal with "the development of a basis for attaining both functional and dimensional compatibility and interchangeability of building components so that they integrate with a minimum of on-site modification, and the establishment of

guidelines for coordinating building systems. This activity is limited to the interface requirements of components or systems or both."

The first technical committee to meet and begin work toward A62 objectives was the Systems Module Committee. This Committee is charged with drafting a proposed standard that will establish a major systems module and preferred component modules. Such a standard is to be used as the basis for coordinating building systems and their components. Initially, attention will be focused on a horizontal systems module. The Systems Module Committee is chaired by W. B. Bennett of the Portland Cement Association. Other members of the Committee are: R. E. Cumrine, Sharp & Handren; D. E. Morgenroth, Owens-Corning; W. K. Platt, American Telephone & Telegraph; G. J. Murray, American Iron and Steel Institute; N. Mitchell, Graduate School of Design, Harvard University; W. K. Raymond, E. F. Hauserman Co.; M. K. Snyder,

*continued on page 207*  
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# LASER DIODE EFFICIENCY AND OUTPUT INCREASED

## Easily Applied Coating Dissipates Heat

Lasers, relatively new electronic components that emit intense beams of coherent light, share at least one problem with other components: they get too hot in use for continuous operation. Some experimenters have improved efficiency by applying an aluminum or silver coating to the laser diode, but with disappointing yields of working specimens.

Research on laser diodes at the NBS Institute for Applied Technology has now resulted in a method of applying an aluminum coating that not only reflects light within the diode, but also helps cool it for more efficient operation and yields over 50 percent greater output power. Herbert K. Kessler, of the Institute's Electron Devices Section, paints the thick aluminum paint on gallium arsenide (GaAs) diodes without short circuiting them electrically. The coating is cheap, easy to apply, and can be tested immediately after application.<sup>1</sup>

### Laser Operation

A laser diode consists of a small piece of semiconductor material, one side of which is n-type and the other p-type. When a voltage is applied between the electrodes of the two areas, the device emits light at a single frequency characteristic of the material,  $0.9 \mu\text{m}$  (at  $20^\circ\text{C}$ ) in the case of gallium arsenide.

Laser diodes cannot normally be operated continuously at room temperature without damage. For this reason they are usually operated in regularly recurring pulses, so that the device can cool during the part of the cycle that it is not emitting. Cryogenic cooling systems are sometimes used to remove the heat, permitting operation at higher duty cycles (longer pulses) without damage.<sup>2</sup> Another way to remove more heat is by better conduction from the diode to the "header" on which it is mounted. This was the NBS approach, coating the diode with a paint which conducts heat readily and is also a good reflector.

### Cooling by Coating

Aluminum and silver coatings have already been used on GaAs lasers for reflection to increase light output. Such coatings are applied by evaporation of the metal on a layer of insulating silicon monoxide covering the device. In practice, however, deposition of the metal is a time-consuming process and the silicon monoxide often breaks down electrically; a high percentage of completed devices



*Herbert Kessler applies a coating of special aluminum paint to a laser diode increasing by over 50 percent the laser light emerging from the front face of the diode.*

are found to be defective when tested. Mr. Kessler solved this problem by using a paint which is not only reflective, but also thermally conducting and a good electrical insulator. A material having these three characteristics is unusual, since good thermal conductors are usually good electrical conductors also.

Diodes which have been coated with the special aluminum paint not only have a power output increased by at least 50 percent for the same current, but also have a lower laser threshold—they emit more readily—due to the improved reflectance at one end. The paint is electrically nonconductive, despite its metallic content, because

of oxidation of the aluminum flakes and the insulating properties of the silicone lacquer.

### Applying Coating

The thick aluminum paint is a mixture of powdered aluminum flakes having dimensions between  $5\text{ }\mu\text{m}$  and  $25\text{ }\mu\text{m}$  and silicone lacquer, in a proportion of 4 to 1 by volume. The paint is brushed liberally over the diode mounted on a header (a transistor base for simplified mounting and connection), except over the front face, from which the beam will emerge. The lacquer dries rapidly and measurements of the optical power output of the diode can be made 3 minutes after coating.

Some diodes of those coated exhibit a power increase of more than 50 percent at this time, but others fall below this increase. The coating can be dissolved from the rejects (ultrasonically in methylene chloride and acetone, for instance) and a new coating applied and tested for satisfactory performance.

The coating apparently has two effects—it improves the optical reflection at the one end of the diode, and it readily conducts heat from the diode to the header. The light output of coated diodes varies slightly among specimens; this is thought to be due to differences in orientations of the flakes.

Experience has shown that the shape of the aluminum particles is an important factor in obtaining the desired reflective effect. Microscopic examination of particles of aluminum of known effectiveness showed that the best results were obtained with the use of flakes, whereas the particles in less effective paint were more rounded.

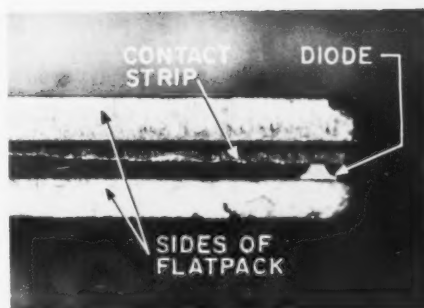
### Further Studies

The simplicity and effectiveness of the painted-on aluminum coating led to consideration of its use for cooling other semiconductor devices. Used on a transistor, it greatly improved operation by providing better heat dissipation via the highly conductive paths from hot spots to the header. The aluminum coating is sufficiently non-conductive electrically to improve the operation of many moderate-voltage, medium-frequency types of semiconductor.

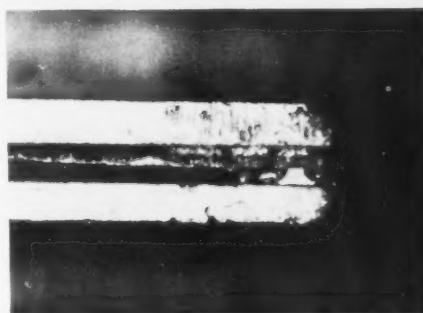
The success of the aluminum paint as a reflector led to experimentation with forms of aluminum assumed to be more reflective. Surprisingly, aluminum foil, bonded to one face of the diode but insulated from it by silicone lacquer, increased diode output power by only 20 percent. In recent investigations aluminized  $50\text{-}\mu\text{m}$  polyester film, applied aluminum side to the diode with silicone lacquer, increased the light output of the diode by nearly 100 percent.

<sup>1</sup> For further information, see Optical power increase in GaAs laser diodes coated with reflecting aluminum silicone mixture, by H. K. Kessler, Proc. IEEE 55, 99-100 (Jan. 1967).

<sup>2</sup> Cryogenic cooler for semiconductor devices, NBS Tech. News Bull. 50, 152-153 (Sept. 1966).



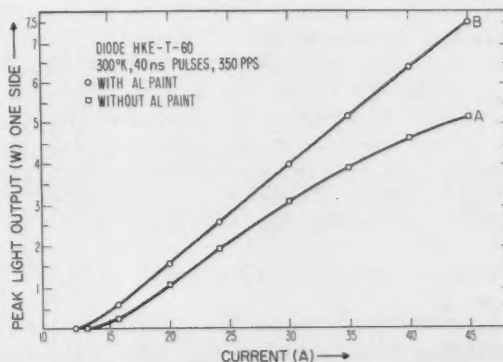
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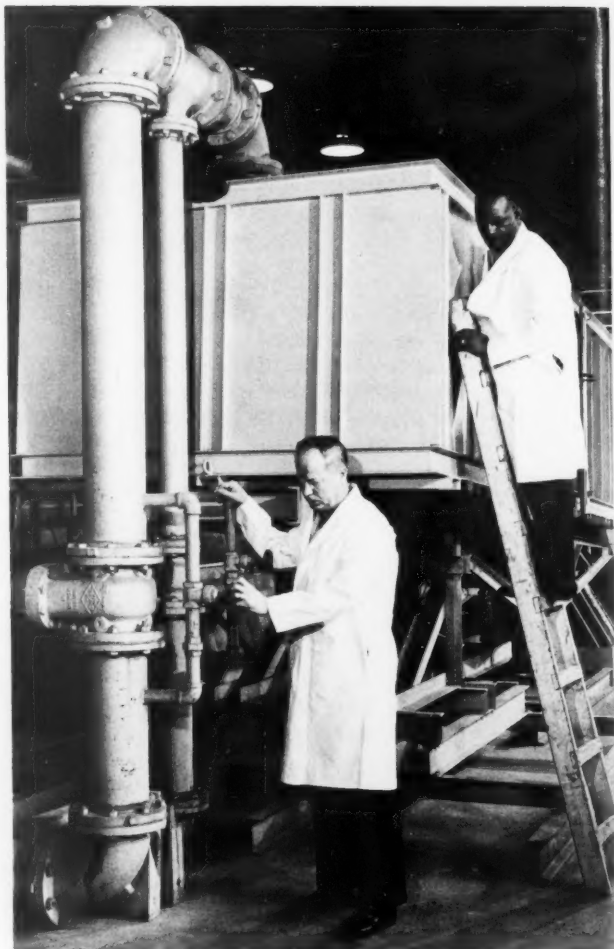
A laser diode mounted on a "flatpack" is shown by an NBS photomicrograph before and after being coated with aluminum paint.

Plot of light output for pulse current of a laser diode at NBS shows that 50 percent greater efficiency and higher output are obtained for diodes painted with special aluminum paint. Note that the treated diode starts to emit at a lower current also.



*A. L. Lembeck (center) and W. Washington perform the final checks on the equipment used with the 4-inch culvert model.*

## EFFICIENT DESIGN FOR HIGHWAY CULVERTS



■ The increased costs of adequate culvert protection of highway fills and the number of new highway complexes have provided a stimulus for hydraulic studies of culvert performance. An investigation<sup>1</sup> of culvert flow under entrance control has been conducted in the hydraulics laboratory of the NBS Institute for Basic Standards, using relatively small hydraulic models of actual field culverts. J. L. French served as project leader. The study was initiated in 1954 and was supported over the intervening years by the Bureau of Public Roads. Since the current expenditure for highway culverts in this country is estimated at \$500,000,000 per year, the use of improved inlet structures is expected to result ultimately in significant savings.

Culverts are large pipes or rectangular conduits used for conveying water under highways while at the same time protecting the road embankment. Normally the flow

through a culvert is a free surface-type of flow, but when storm or high-water conditions prevail the culvert entrance may be fully submerged. Unless the excess water is rapidly carried off, the highway fill will be inundated and will become eroded.

The NBS study of flow through culverts placed emphasis on the design of entrance shapes to increase the flow capacity. This investigation has shown that improved design of the inlet structure can, in some cases, double the water-carrying capacity over that of a conventional straight culvert of the same diameter. This result is accomplished by the use of some or all of the following features: a beveled leading edge at the inlet face, a tapered or cone-shaped inlet, and fall concentration in the inlet structure.

### Beveled Edge

The improvement of the leading edge of a culvert inlet

*NBS Technical News Bulletin*

by beveling is simple and hydraulically efficient. It increases the flow capacity of the inlet face by decreasing separation effects in this region of the inlet structure.

### Tapered Inlet

The tapered or cone-shaped inlet to the culvert performs an important function in entrance control. The enlarged face at the entrance to the culvert permits the tapered downstream portion of the inlet structure to serve efficiently as the flow-controlling element of the inlet with consequent increase in overall capacity.

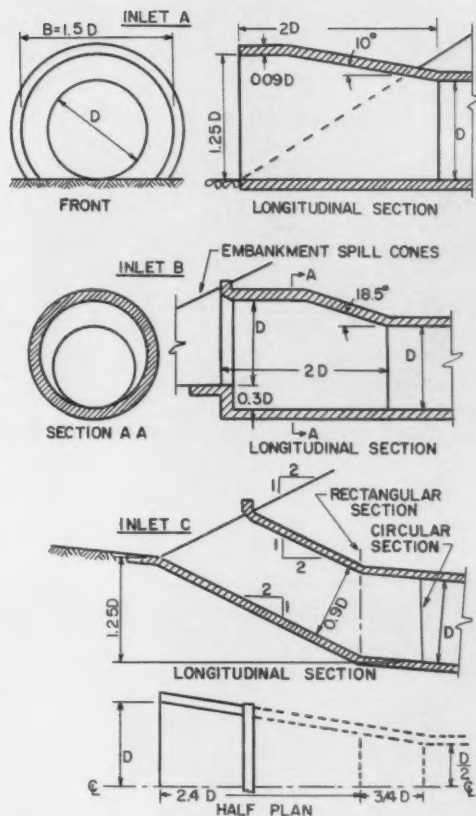
### Fall Concentration

A fall concentration consists of a vertical drop at the face of the inlet structure, or an inlet section whose slope is substantially greater than the slope of the culvert. Fall concentration is effective in increasing the rate of flow only when the culvert is operating in entrance control—that is, when the culvert is sufficiently sloped so that the culvert barrel does not limit or control the capacity of the structure. When these conditions are met, fall concentration in the inlet structure is an effective method of improving the performance or capacity of a culvert.

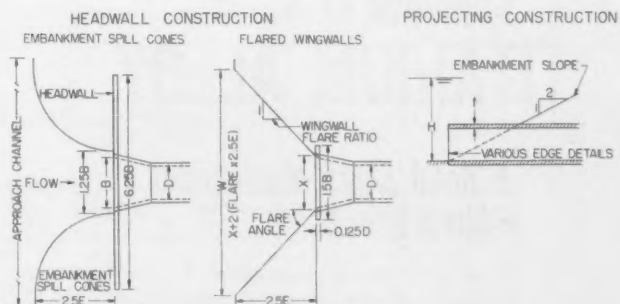
### Laboratory Models

Small-scale models are widely used to research hydraulic problems for standardized designs and important structures. The NBS study used models of both round and rectangular culvert barrels ranging in size from 4 inches to 30 inches. The models consisted of a tapered inlet, a transition barrel, and an outlet. The tests were conducted in channels proportionate to the size of the model being tested. The rate of flow through the models was measured by orifice flowmeters and weirs while the pool depth was monitored by a suitably located manometer. The results of the culvert model studies are applicable to the design of highway culverts in the field.

<sup>1</sup> Tapered inlets for pipe culverts, by J. L. French, J. Hydr. Div., ASCE 90, HY2, 255 (1964); also J. L. French, discussion of Flow in culverts and related design philosophies, by F. Blaisdell, J. Hydr. Div., ASCE 93, HY1, 85 (1967).



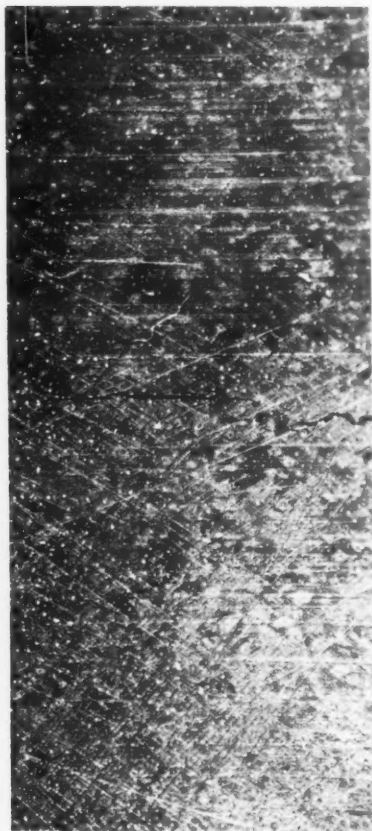
Front and cross-sectional details of three of the face sections used in a study of highway culverts, showing face enlargement. Inlet C is an example of steep barrel slope at the entrance to a culvert.



Details of the construction of headwall and projecting entrances used in a model study of highway culverts.



*Hugh L. Logan examines a hollow cylinder specimen, loaded in a stress corrosion rack, before placing an electric furnace around it.*



*Interior of a hollow cylinder specimen after failure by cracking. (X15)*

■ The titanium alloy, Ti-8Al-1Mo-1V, because of its light weight and ability to withstand high temperatures, is being considered as a wing covering material for the supersonic transport aircraft. The corrosive reactions to which the alloy will be subjected in this application have been studied under carefully controlled conditions by H. L. Logan and associates<sup>1</sup> of the NBS Institute for Materials Research under the sponsorship of the National Aeronautics and Space Administration. Specifically, the project was initiated to learn more about the mechanisms of the stress-corrosion cracking of titanium alloys at elevated temperatures in a salt environment.

Ti-8Al-1Mo-1V exhibits a high strength-to-density ratio and possesses good mechanical properties. However, like other titanium alloys, it is known to fail by stress-corrosion cracking when in contact with chlorides at temperatures above 290 °C (550 °F). No theory for the mechanism of failure has been satisfactory in the past. The results of this investigation suggest a solid state mechanism.

In this study, stress-corrosion tests were performed on sheet metal and hollow cylinder specimens of the titanium alloy in contact with solid sodium chloride or synthetic sea salt (7 parts NaCl and 1 part MgCl<sub>2</sub>). Since many of today's airports are located near the seacoasts, it was necessary to include the NaCl-MgCl<sub>2</sub> mixture as one of the corrodents. However, no significant difference was found between the results obtained with the synthetic salt mixture and those obtained with sodium chloride alone.

The surface of the annealed sheet metal specimen (1.02-mm or 0.04-inch thick) was coated with NaCl, stressed as a bent beam by four-point loading to 40 to 80 percent of its yield strength, and heated in air at 427 °C (800 °F). Failures occurred in 64 to 91 days.

X-ray diffraction studies were then made on the corrosion products, both those found at cracking tempera-

## STRESS-CORROSION CRACKING OF A TITANIUM ALLOY

### A Solid State Mechanism of Failure Proposed

*A titanium alloy specimen which failed as the result of a complete tensile fracture. The specimen was heated to 400 °C and stressed in tension to 90 percent of the yield strength of the material at that temperature. (X1½)*

tures and those found on subsequent cooling to room temperature. These studies showed the usual oxides of titanium as well as an unidentified phase which may be the result of a reaction between NaCl and the oxide.

To prepare the hollow cylinder specimens,<sup>2,3</sup> blanks about 15 cm (6 inches) long were cut from the rod stock, annealed, and machined out. A reduced section was machined symmetrically on the outer surface about the longitudinal axis. The cavity was filled with a solution of either NaCl or the NaCl-MgCl<sub>2</sub> mixture. After the solution was pipetted out, permitting crystals to form on the inner surface, the specimen was closed with a plug. By extending a small-diameter tube through this plug to the interior, an oxygen or argon atmosphere could be introduced. The specimen was heated to 400 °C (750 °F) and stressed by means of a lever system in direct tension to 90 percent of the yield strength of the material (about  $5.068 \times 10^8$  N/m<sup>2</sup> or 73,500 psi). Gas samples could be collected from the interior by a sampling tube. Thermocouples were attached to the shoulders of the specimen and to the center of the reduced section. The specimen was used to investigate the role of an atmosphere on stress-corrosion cracking and to enable examination of the gaseous reaction products by mass spectrographic methods.

The hollow cylinder specimen failed either by a single crack penetrating through the wall and equalizing the pressure or by a complete tensile fracture. Cracking was produced in specimens coated with the NaCl-MgCl<sub>2</sub> mixture or with NaCl, provided oxygen or water vapor was present. Both the oxygen and water vapor are believed to react with the alloy at 400 °C to form a solid oxide on the metal surface.

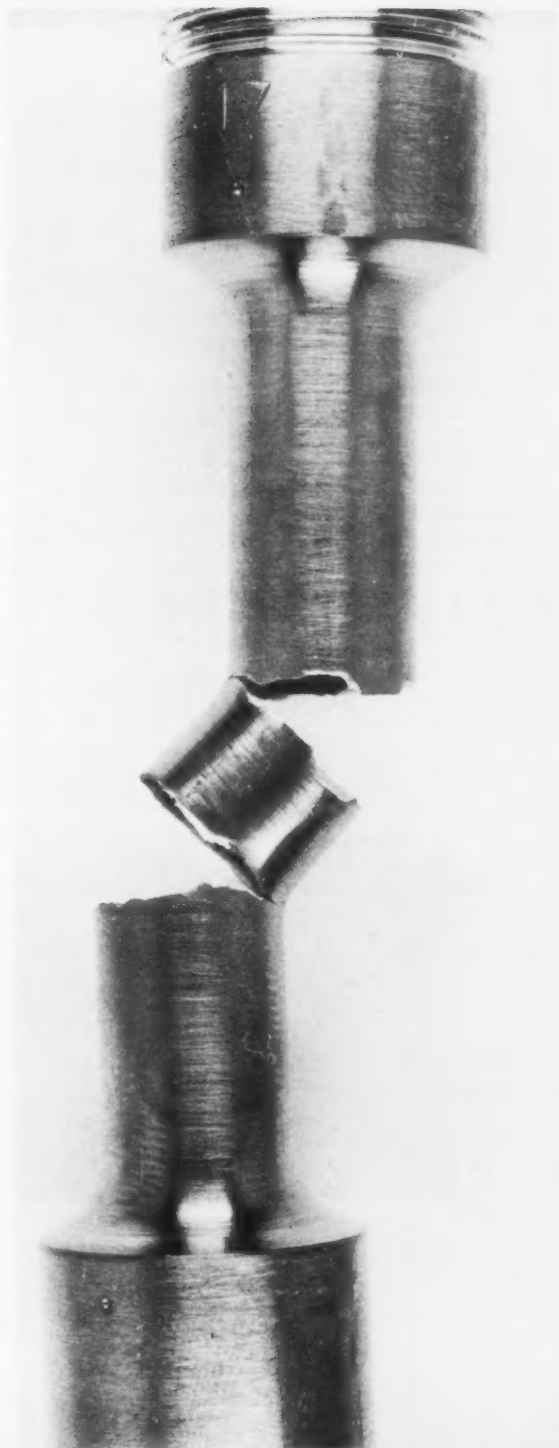
Cracking could also be produced in an inert atmosphere in specimens preoxidized prior to coating with a chloride. However, a preoxidized specimen without a chloride coating did not fail in a 600-hour exposure. This indicates that stress-corrosion cracking was due to the presence of chlorides and oxygen in the free or combined form.

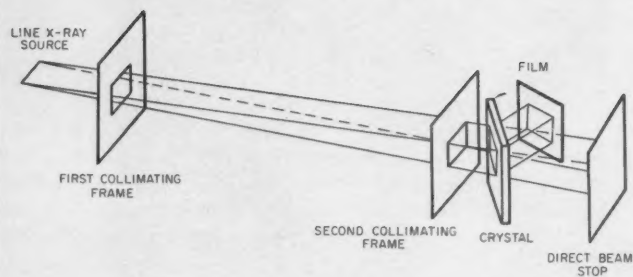
These results have led the authors to propose that the chloride ion diffuses down a stress gradient, and probably down an oxygen concentration gradient, meanwhile reacting with the alloy to destroy atomic bonds and to produce stress-corrosion cracks.

<sup>1</sup> For further information, see Chemical and physical mechanisms of salt stress-corrosion cracking in the titanium 8-1-1 alloy, by H. L. Logan, M. J. McBee, C. J. Bechtoldt, B. T. Sanderson, and G. M. Ugiansky, Stress Corrosion Cracking of Titanium, ASTM Spec. Tech. Publ. No. 397, 215 (1966).

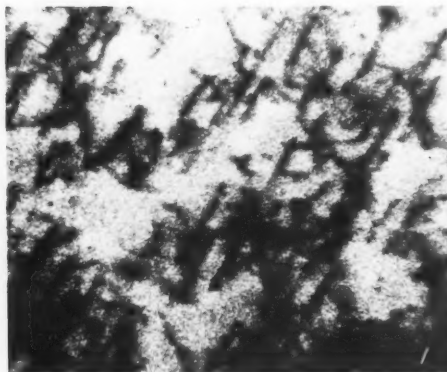
<sup>2</sup> Stress-corrosion studies of stainless steel, NBS Tech. News Bull. 47, 180 (1963).

<sup>3</sup> A specimen for use in investigating the stress-corrosion cracking of metals at elevated temperatures, by H. L. Logan, Mat. Res. Stand. 2, 98 (1962).





## INEXPENSIVE, HIGH-QUALITY X-RAY CAMERA DEVELOPED



*A schematic drawing of the x-ray camera presents the geometry of the experimental approach.*

Metallurgists, materials scientists, and solid state physicists are making increasing use of x-ray diffraction techniques in their analysis of crystalline structures. Studying the imperfections in crystals is often more important than studying perfect crystals, since the defects determine the actual behavior of the material. Commercial x-ray cameras designed for this purpose perform very well but are out of range financially for many research groups.

An x-ray diffraction camera that compares favorably in quality with commercial instruments can now be constructed in the laboratory at minimal cost. Economic considerations do not place any limitations on overall versatility of this device nor appreciably affect its exposure times. Requiring virtually no additional equipment other than an x-ray source, the camera produces a topographical image of a crystal using both normal and Borrmann transmissions with good results. The geometry of this camera was devised by H. P. Layer and R. D. Deslattes of the NBS Institute for Materials Research.<sup>1</sup>

The mechanical construction of the camera is simple and consists only of a mount for the x-ray tube and a goniometer for securing the crystal in correct relation to the impinging x-ray beam. Originating from an x-ray line source, the beam passes through two collimating frames before striking the crystal and being deflected to the photographic film. The crystal is placed adjacent to the second collimating frame and oriented to satisfy the conditions for diffraction; the film may be set perpendicular to the diffracted beam or parallel to the crystal surface and as close to the crystal as possible while avoiding the direct radiation. Personnel safety was provided for by enclosing the x-ray beam in a brass tube. Evacuating this tube reduced air absorption losses.

A silicon single crystal whose structure has been well established was selected to check experimentally the quality of the instrument. A representative topographical image of the crystal showed the camera to have a high spatial resolution accompanied by a low sensitivity to the lattice distortion of the crystal.

<sup>1</sup>For further information, see *A simple nonscanning camera for x-ray diffraction contrast topography*, by Howard P. Layer and Richard D. Deslattes, *J. Appl. Phys.* **37**, 3631 (1966).

*Above: The image of a dislocation appears as a dark line in the photomicrograph. The low-cost x-ray camera produced this normal transmission topograph of a silicon crystal (0.5 mm thick) exposed to Mo K $\alpha$  radiation for 16 hours.*

*Below: In a topograph of the same crystal dislocations appear as light lines when using Borrmann transmission in the camera. This crystal was exposed to Cu K $\alpha$  radiation for 8 hours.*

*NBS Technical News Bulletin*



# STANDARDS AND CALIBRATION

## CALIBRATION SERVICE ANNOUNCED FOR MICROWAVE POWER IN WR 42 WAVEGUIDE (18.0 to 26.5 GHz)

The NBS Radio Standards Laboratory at Boulder, Colo., announces a calibration service for the measurement of effective efficiency and calibration factor of bolometer units and bolometer-coupler units in WR 42 waveguide. Although calibrations can be performed at any frequency in the useful range of the waveguide (18.0 to 26.5 GHz), it is more economical to the customer if calibrations are performed at the selected<sup>1</sup> frequencies of 19.8, 22.0, and 23.8 GHz.

The quantities measured in these services have the following definitions:<sup>2</sup>

*Effective efficiency of bolometer units:* the ratio of the substituted d-c power in the bolometer unit to the microwave power dissipated within the bolometer unit.

*Calibration factor of bolometer units:* the ratio of the substituted d-c power in the bolometer unit to the microwave power incident upon the bolometer unit.

*Calibration factor of bolometer-coupler units:* the ratio of the substituted d-c power in the bolometer unit on the side arm of the directional coupler to the microwave power incident upon a nonreflecting load attached at the output port of the main arm.

The effective efficiency of bolometer units in the WR 42 waveguide size is measured with an uncertainty of  $\pm 1$  percent. The calibration factor can be measured with an uncertainty ranging up to  $\pm 1.3$  percent. The uncertainty in the measurement of calibration factor of a bolometer-coupler unit may extend up to  $\pm 1.5$  percent.

The element of the bolometer unit submitted for calibration may be of the barretter or thermister type and of either 100- or 200-ohm resistance operating at a bias current between 3.5 and 15 mA. The bolometer units should be of either the fixed-tuned or untuned broadband type. Measurements are made on bolometer units over a power range of 0.1 to 10 mW.

Power measurements can be made on bolometer-coupler units in WR 42 waveguide with coupling ratios from 3 to 20 dB. A bolometer unit of either the fixed-tuned or untuned broadband type must be permanently attached to the side arm of the coupler. The coupler should have a directivity no less than 40 dB and a VSWR no greater than

1.05 for the input and output ports of the main arm of the coupler.

## PEAK-PULSE POWER CALIBRATIONS EXTENDED IN FREQUENCY RANGE

The initial service provided by the NBS Radio Standards Laboratory (Boulder, Colo.) of calibrating instruments for measuring the peak power of pulsed signals in coaxial systems has been augmented by a service in the frequency range of 300 to 500 MHz. The initially available service covered the frequency range of 950 to 1200 MHz.<sup>1</sup>

As before, both feed-through and terminating types of instruments can be calibrated. These instruments, in turn, can serve as transfer standards for measuring the output of equipment, such as radar, telemetry, and other pulsed communication systems.

Measurement of peak power can be made over a range of 1 mW to 2.5 kW at pulse durations in the range of 2 to 10  $\mu$ sec and at pulse repetition rates from 100 to 1600 pps. The maximum duty factor of the present equipment is limited to 0.0033.

Calibrations are performed over this extension of the frequency range with limits of uncertainty no greater than  $\pm 3$  percent.

## STANDARD FREQUENCY AND TIME BROADCASTS

WWV—2.5, 5.0, 10.0, 15.0, 20.0, and 25.0 MHz

WWVH—2.5, 5.0, 10.0, and 15.0 MHz

WWVB—60 kHz

Radio stations WWV (Fort Collins, Colo.) and WWVH (Maui, Hawaii) broadcast signals that are kept in close agreement with the UT2 scale by making step adjustments of 100 ms as necessary. Each pulse indicates that the earth has rotated approximately 15 arcseconds about its axis since the previous one. Adjustments are made at 0000 UT on the first day of a month. *There will be no adjustment made on 1 October 1967.* The pulses occur at intervals that are longer than 1 second by 300 parts in  $10^{10}$  due to an offset in carrier frequency coordinated by the Bureau International de l'Heure (BIH), Paris, France.

Radio station WWVB (Fort Collins, Colo.) broadcasts seconds pulses derived from the NBS Time Standard (NBS-III) with no offset. Step adjustments of 200 ms are made at 0000 UT on the first day of a month when necessary. BIH announces when such adjustments should

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# CONFERENCE & PUBLICATION *Briefs*

## SEMINAR ON LOW FREQUENCY ELECTRICAL STANDARDS

As part of the program of Precision Measurement Seminars conducted at the National Bureau of Standards for the past 4 years, a seminar on Low Frequency Electrical Standards will be held at the Bureau's new site at Gaithersburg, Md., from December 11 to 13, 1967. Sponsored by the Electricity Division of the NBS Institute for Basic Standards, this seminar is designed to provide advice and assistance on measurement and calibration problems encountered by calibration and standards laboratories. F. L. Hermach will act as the seminar coordinator.

The seminar will present information on the accurate measurement of electrical quantities and the calibration of electrical standards. It will cover the measurement methods used by the Bureau to establish and maintain the basic electrical units and to calibrate customers' standards of resistance, inductance, capacitance, voltage, current, and power from direct current up through 30 kilohertz. The program will consist of lectures and demonstrations in the Electricity Division laboratories. Emphasis will be on measurement techniques which should be useful to workers in standards and calibration laboratories.

Attendance at this seminar will be limited to 50 persons and, for the laboratory demonstrations, the group will be divided into subgroups. The fee for the seminar will be \$90.

Candidates must have undergraduate college-level training in physics or electrical engineering and must be currently engaged in professional work in precise electrical measurements, at a level involving the basic reference standards of a calibration or standards laboratory. Preference will be given to those whose position involves the training of others in precise electrical measurements.

Transportation between Washington, D.C., and the Bureau's site in Gaithersburg, Md., will be provided. Information on hotel accommodations for attendees will be sent with the notice of acceptance. Those qualified and interested in attending should apply to:

R. F. Dziuba  
B-162, Metrology Building  
National Bureau of Standards  
Washington, D.C. 20234

## FIFTY-SECOND NATIONAL CONFERENCE ON WEIGHTS AND MEASURES

### Consumer Problems Accented

The Fifty-Second National Conference on Weights and Measures was held June 26-30 at the National Bureau of Standards' new Gaithersburg (Md.) laboratories and the Sheraton Park Hotel in Washington, D.C. More than 500 representatives—State and local weights and measures officials, Federal officials, and representatives from consumers, industry, and business—were in attendance.

This year's Conference had a strong consumer orientation; one of its highlights was a special seminar on the Fair Packaging and Labeling Act. Other topics covered in the Conference included space age measurements, special measurement problems in aerosol packaging and petroleum products, ladder measurement and labeling, measurement problems of the scale manufacturer, and automatic data processing in weights and measures.

Founded and sponsored by the National Bureau of Standards, the National Conference on Weights and Measures is one of the principal forums for discussion of consumer affairs in the Nation. It is the meeting ground for all levels of government concerned with weights and measures administration, industries associated with weighing and measuring equipment and packaging, and industries that offer their products for sale in weighed and measured quantities. The concern of the Conference is protecting both buyer and seller—from short measure, which defrauds the buyer, or from long measure, which deprives the seller of his just profit. To this end, the Conference considers both weights and measures laws and regulations and the technology of weighing and measuring.

*Delegates to the weeklong Fifty-Second National Weights and Measures Conference are shown the NBS nuclear reactor.*





*Secretary of Commerce Alexander B. Trowbridge addresses attendees of the Fifty-Second National Weights and Measures Conference.*



*Miss Betty Furness, Special Assistant to the President for Consumer Affairs, was the guest speaker at a luncheon for members of the Fifty-Second National Weights and Measures Conference. Miss Furness stressed the importance of standards to the consumer.*

Secretary of Commerce Alexander B. Trowbridge was one of the principal speakers on the Conference program. He stressed the importance of common reference standards saying, "They are the basic language of manufacture that makes mass production possible, and the unifying factor that both shapes and defines the limits of the mass market that is so essential to our progress and prosperity." Speaking on voluntary standards the Secretary said, "We now have in effect about 500 voluntary product standards developed through Commerce procedures, and at least 13,000 developed through private associations. This great system of standardization operates in the best American traditions of individual freedom and national cooperation—and we intend to expand and build on it to meet the new challenges ahead."

The Secretary was followed by Dr. R. D. Huntoon, Acting Chief, NBS Office for Program Development and Evaluation, who spoke on the National Measurement System. He stressed the importance of measurements that are made daily and pointed out the enormous challenges that

lie ahead in keeping measurement science abreast of expanding scientific and technological requirements.

Miss Betty Furness, Special Assistant to the President for Consumer Affairs, was guest speaker at a luncheon on Tuesday, June 27. Miss Furness spoke on the importance of standards—both measurement standards and legislated standards—to the consumer.

A special feature on Wednesday, June 28, was a round table discussion on the new Fair Packaging and Labeling Act, moderated by M. W. Jensen, Chief, Office of Weights and Measures, NBS Institute for Applied Technology, and Executive Secretary of the Conference. Representatives of the Food and Drug Administration, the Federal Trade Commission, and the Department of Commerce, along with industry and consumer representatives, participated.

The theme of the Thursday, June 29, morning session was measurement and measurement problems in several diverse fields. Talks were given on ladder measurement, measurement of aerosols, space age measurement, weights and measures and scale manufacturers, and meter measurement in the petroleum industry.

The remainder of the conference was devoted to committee meetings, a tour of the NBS Gaithersburg (Md.) laboratories, a report on the program of the NBS Office of Weights and Measures, and a report on Hawaii's program of weights and measures.

## NBS TECHNICAL HIGHLIGHTS

A review of current research programs and an expanded look at the new scientific research complex in Gaithersburg, Md., are contained in the 1966 *Technical Highlights of the National Bureau of Standards*. This annual report also contains information on recent management changes at the Bureau and supplementary information on Bureau organization, personnel, budget, and technical publications of the staff. Special attention is given to the National Standard Reference Data System and current work in automatic data processing.

The discussion of the Bureau's new 565-acre research complex provides an interesting historical sketch of the years of planning preceding the move. In addition there is detailed discussion of the physical plant and the systems employed to insure smooth operation and to provide the scientific staff with the necessary tools to carry on their research. Particular attention is given to a discussion of the special purpose laboratories and research facilities such as the 100-million electron-volt linear accelerator, the 10-million watt research reactor and the engineering mechanics laboratory housing a 12-million pound hydraulic force testing machine—the largest of its kind in the world.

Notable scientific and technical accomplishments mentioned in the annual report include:

- \*Development of a mass standardization program which permits evaluation of industrial mass-measuring procedures at a tremendous savings of time and money;

*continued*  
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## BRIEFS *continued*

- \*Observation of a number of atomic spectra in the vacuum ultraviolet never before seen;
- \*Development of a system for illuminating aircraft propeller blades thus helping to decrease accidents among crewmen working on planes at night;
- \*Discovery of superconductivity in an oxide semiconductor single crystal;
- \*Application of a method previously used on building materials to the determination of the strength of dental cements;
- \*Development of a method to predict the failure of transistors before transistors are put into use;
- \*A study of the effects of smoke created by burning aircraft materials;
- \*Development of a simple, rapid procedure for checking the delivered weight of products packaged in aerosol containers;
- \*Design of a seat belt test machine which dynamically simulates key aspects of automobile crashes;
- \*Completion of a cost-benefit study to help the Weather Bureau improve the quality of its services to the public;
- \*Development of a sensor which indicates rate of blood flow and requires only that one small electrode be inserted into the blood stream.

*1966 Technical Highlights of the National Bureau of Standards*, Annual Report, Fiscal Year 1966, Miscellaneous Publication 283, 182 pages, 60 cents. (Order from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402; the Clearinghouse for Federal Scientific and Technical Information, Springfield, Va. 22151; or from local U.S. Department of Commerce Field Offices.) (Foreign remittances must be in U.S. exchange and should include an additional one-fourth of the publication price to cover mailing costs.)

## COLORS OF SIGNAL LIGHTS

As the Nation's transportation networks become increasingly crowded, the safety of the traveler is an ever-growing problem. One of the major aspects of traveler safety is the proper utilization of the colors of signal lights. Often, these signal lights must be observed and correctly interpreted at high speeds in dense traffic by drivers who are highly dependent upon them.

NBS Monograph 75, *Colors of Signal Lights: Their Selection, Definition, Measurement, Production and Use*, by F. C. Breckenridge, is a complete analysis of the problem of signaling, with the technical information necessary for preparing and appraising specifications for the colors of signal lights. Based on previous Bureau research and the recommendations of the United States National Committee on Color for Signal Lights, the material is presented in such a way as to aid those interested in signal light colors

in comparing the technically established information with the requirements of the individual situation.

## AUTOMATIC TYPESETTING

One of the major programs of the NBS Center for Computer Sciences and Technology is the collection and evaluation of current developments in the field of information processing and retrieval. NBS Monograph 99, *Automatic Typographic-Quality Typesetting Techniques: A State-of-the-Art Review*, by M. E. Stevens and J. L. Little, is a compilation of this information intended to improve cooperation in the fields of information selection, systems development, information retrieval research, and mechanized translation. Beginning from either of two sources—keyboard entry of manuscript material or mechanized input in the form of perforated tapes or magnetic tapes—this volume describes the state-of-the-art in automation of graphic arts composition.

Of particular importance to document processing and publishing operations, Monograph 99 presents reports of many of the new techniques for typographic-quality automated composition. Due to the ever increasing amount of scientific literature being generated, the incorporation of mechanized processes in as much of the publication cycle as possible is becoming a necessity in most operations concerned with information dissemination. A volume of this nature, containing a bibliography with almost 400 references, thus becomes an indispensable guide to the implementation of successful techniques and systems for automated publication.

## TRACE CHARACTERIZATION

*Trace Characterization—Chemical and Physical*, NBS Monograph 100, W. W. Meinke and B. F. Scribner, Editors, is the proceedings of the First Institute for Materials Research Symposium. As the field of materials research has advanced and matured in the past few years, the problem of meaningful measurement of "traces," chemical contaminants or physical defects, has become critical. The symposium, held October 3 to 7, 1966, brought together the leading authorities from the United States and abroad to discuss the entire spectrum of chemical and physical trace characterization.

This was the first major attempt to demonstrate the interrelationships between the various disciplines involved in physical and chemical characterization, especially in the detection and determination of trace amounts of defects and "foreign" substances. The proceedings present a well-rounded treatment of each of the subject areas discussed. Ranging from state-of-the-art summaries, through discussions of the present research efforts, to glimpses of the problems to be faced in the future, this volume should provide essential guidance in materials research for many years to come.

## COMPONENTS AND SYSTEMS *continued*

Butler Manufacturing Co.; H. F. Hann, Sears, Roebuck & Co.; G. Hanson, Sallada & Hanson; and L. Perlmutter, Prestressed Concrete of Colorado, Inc.

A second technical committee began work April 29 to develop a classification format for modular system types to be used as a basis for further work. This committee is chaired by James Gross of Structural Clay Products Association. Its other members are: W. E. Bryant, National Association of Home Builders; R. E. Cumrine, National Council on School Construction; R. Cowling, American Institute of Architects; D. P. Jenny, Prestressed Concrete Institute; J. A. Parker, General Services Administration; J. Moore, Department of Housing and Urban Development; and J. I. Zerbe, National Forest Products Association.

Within the next few weeks other technical committees of A62 will begin drafting other proposed standards that are considered essential to form the groundwork for developing a comprehensive modular discipline for the coordination of building systems and components. Work of the A62 Committee follows USASI procedure and is under the direction of the A62 Executive Committee consisting of: J. E. Gaston, Armstrong Cork; R. A. LaCosse, Insu-

lation Board Institute; J. G. Gross, Structural Clay Products; R. D. Murphy, Creative Buildings, Inc.; W. B. Bennett, Portland Cement Association; and R. W. Smith, NBS.

A62 seeks to develop guidelines, following modular principles, for completely coordinated building systems. Such guidelines, when adhered to, should allow design of precoordinated components that will assemble into coordinated building systems with little or no additional modification.

Such guidelines will be for open systems (nonproprietary) and will provide for interchangeability between systems, between components, between parts, and with conventional construction. The intent of proposed A62 coordination is not to impose a stereotyped discipline on all construction, but to make the economy of components, which are preplanned to assemble into complete systems, available to the architect when and where they can be utilized. Variety of placement, flexibility of design, interchangeability of materials, and compatibility with conventional construction are inherent in the anticipated coordination effort.

<sup>1</sup> See Committee to aid in pre-coordination of building components and systems, NBS Tech. News Bull. 50, No. 10, 176 (Oct. 1966).

## STANDARDS AND CALIBRATIONS *continued*

be made in the scale to maintain the seconds pulses within about 100 ms of UT2. *There will be no adjustment made on 1 October 1967.*

### CHANGE IN RSL FEES

Effective July 1, 1967, calibration charges made to public customers by the Electronic Calibration Center (ECC) were increased. Charges which were previously \$20 per hour are now \$40 per hour; charges which were previously \$25 per hour are now \$45 per hour. These charges affect calibration services in the high frequency and microwave regions (30 kHz and up) which are performed by the Radio Standards Laboratory at Boulder, Colo.

### BOOKLET ON MICROWAVE ATTENUATION

A tutorial survey of interest to microwave measurement laboratories was issued recently by the NBS Institute for Basic Standards under the title, NBS Monograph 97, *Microwave Attenuation Standards and Measurements*. Prepared by R. W. Beatty of the Radio Standards Laboratory in Boulder, Colo., the 45-page publication is for sale, at 25

cents per copy, by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

The monograph presents an introductory, inclusive review of microwave measurement methods and standards. It presents some relatively new material on basic concepts including a more rigorous analysis of mismatch and connecting errors.

Particular attention is given to analysis and discussion of errors in methods that permit the highest precision. The means by which confidence is developed in attenuation standards are described, and criteria are given which attenuators should satisfy if they are to be worthy of precise calibration. Methods of measurement are classified, including those not requiring any attenuation standard, and each method is evaluated on the basis of convenience and accuracy.

A list of selected references, covering most of the significant developments in the field, is included.

<sup>1</sup> In performing microwave calibrations, a considerable amount of time usually is needed to prepare the system for measurement operation. Much of this preparation is related to adjustment of the system to the frequency of operation selected for the calibration. Time and cost often can be reduced by minimizing the number of times the operating frequency of the calibration system must be readjusted.

<sup>2</sup> For further information, see *Bolometric microwave power calibration techniques at the National Bureau of Standards*, by R. F. Desch and R. E. Larson, IEEE Trans. Instr. Meas. IM-12, No. 1, June 1963.

<sup>3</sup> For further information, see *Peak-pulse power calibrations initiated*, NBS Tech. News Bull. 45, No. 12, 212-213 (Dec. 1965).



# NEWS

## Codata

During the past 2 years considerable interest has developed in the possibility of an international cooperative program to compile data on the properties of substances. Such activities would have the benefits of sharing the workload, making use of scarce talent, and promoting international scientific relations. A recent development has been the establishment of a Committee on Data for Science and Technology (CODATA) under the auspices of the International Council of Scientific Unions. (See *NSRDS News*, Tech. News Bull. 51, No. 1, Jan. 1967.) This Committee came into existence in January 1966 with a directive to promote international cooperation, to serve as a channel of communication among projects in various countries all over the world, to encourage more scientists to undertake projects of this type, and to make recommendations about needs and priorities to persons responsible for funding these kinds of projects in the various countries. Membership in CODATA consists of national representatives from the United States, United Kingdom, USSR, France, Germany, and Japan, plus representatives of those international scientific unions that wish to participate. Ten unions have chosen to do so.

## Moscow Meeting

The second annual meeting of CODATA was held at the Soviet Academy of Sciences in Moscow on May 31, June 1 and 2, 1967, under the chairmanship of F. D. Rossini, Dean of Science at Notre Dame University. Attending from the United States, besides Prof. Rossini, were G. Waddington, executive director of the Central Office of CODATA, and E. L. Brady, Chief, NBS Office of Standard Reference Data. Also present were observers from governmental programs which fund data compilation programs in the adhering countries. All members of the U.S.S.R. National Committee for CODATA were invited guests.

A welcoming statement was delivered by N. N. Semenov, a vice president of the Academy of Sciences and a Nobel laureate, who stressed the great value of evaluated critical constants and the importance and difficulty of the evaluation process: "Mere collection of data is not enough—there must be an evaluation by competent scientists who will carry out a critical treatment involving all data rele-

vant to a particular situation. There must be a searching for and 'turning upside down' of all relevant information."

A decision made at the Moscow meeting was to hold, jointly with the German Chemical Society, the First International CODATA Conference, probably in the first week of July 1968. It will be held near Frankfurt, Germany, and will be run on a plan similar to the Euchem and Gordon Conferences. Announcements will appear elsewhere and interested persons will be invited to submit applications to attend.

## Task Group on Computer Use

The CODATA Task Group on Computer Use, previously announced (*NSRDS News*, Tech. News Bull. 51, No. 7, July 1967), met on June 8 in Paris. The meeting was attended by F. L. Alt, Chairman (formerly of the NBS Office of Standard Reference Data and now with the American Institute of Physics), N. Jones (NRC Ottawa, Canada), G. Black (U.K. Computer Center), R. Fugmann (Farbwerke Hoechst AG., Frankfurt/Main, Germany), F. Schulte-Tigges (German Computer Center), and J. d'Olier (Centre de Documentation du C.N.R.S., Paris, France), representing five of the member countries of CODATA. The other member countries, Japan and the Soviet Union, did not send representatives. Also present were four invited observers representing three international organizations, Dr. Waddington, representing CODATA, and a few representatives of French organizations interested in the Group's activities. The meeting heard status reports from the members and discussed four projects for future activities. It agreed to make an immediate start on two of these; namely, a survey of automation projects in data centers, and a list of computer programs for use by such centers. It decided to postpone the other two until some progress had been achieved on the former, meanwhile attempting to secure financing. Dr. Jones was elected Secretary of the Task Group. Mr. d'Olier accepted the chairmanship of an Editorial Subcommittee consisting of himself, Prof. Black, and Dr. Fugmann.

## Royal Society Symposium on Data for Science and Technology

To further the participation of the U.K. in the affairs of CODATA, the Royal Society has organized a British National Committee on Data for Science and Technology,

with Sir Gordon Sutherland, Master of Emmanuel College, Cambridge, as Chairman. To inform the British technical community about the activities of CODATA and national programs in other countries, the British National Committee organized a "Meeting for Discussion on Data for Science and Technology" at the Royal Society headquarters in London on Monday, June 5, 1967. Prof. Rossini spoke on the purposes and objectives of CODATA; Dr. Waddington presented a progress report; and Dr. Brady detailed U.S. efforts of the National Standard Reference Data System. H. Stussig, Vice Chairman, Federal Republic of Germany National Committee on Data, spoke on activities in the Federal Republic of Germany. The afternoon session consisted of a general review of data activities in the United Kingdom, with reports by Harry Hookway, director of the Office of Scientific and Technical Information of the Department of Education and Science; C. G. Giles of the Ministry of Technology; and T. M. Sugden, research director of Shell Research, Ltd. The Royal Society plans to publish the papers and the discussions that followed the presentations.

#### Low Temperature Specific Heats Data Center

The Low Temperature Specific Heats Data Center, NBS Institute for Basic Standards, evaluates literature data on heat capacity between 0 and 300 °K. It also investigates the use of computer techniques for data analysis and ways of presenting the results most usefully. Because heat capacity can be determined with a high degree of accuracy, and because thermodynamic functions can be derived from heat capacity, the products of this Data Center are expected to be widely used by the scientific and technical community.

Headed by G. T. Furukawa, the Center is engaged in experimental thermodynamic measurements and data analysis. Its efforts are oriented toward the highest standards of accuracy in experimental measurements and toward continual improvement of calorimetric techniques and instrumentation. Developments in other laboratories are closely followed. The Center serves as a focal point for information on calorimetric techniques and instrumentation, sources of heat capacity data, and computer techniques for data analysis.

The Center has on file about 12,000 documents containing data on calorimetry, heat capacity, enthalpy, and other related information essential to precise analysis of heat data. The literature references to over 10,000 of these documents are filed by author on edge-punched cards. The cards are used both to retrieve the documents and to compose bibliographies on an automatic typewriter. Data are also being stored on punched cards for the purposes of analysis. In the design of the card format, future storage of the cards, and their use with magnetic tapes were considered.

To reduce its library work and to direct more of its efforts toward critical data analysis, the Center recently

began to use the services of the Thermophysical Properties Research Center (Purdue University, West Lafayette, Ind. 47906), and the NBS Cryogenic Data Center (Boulder, Colo. 80302) for bibliographic sources of heat capacity data. At present, the Center is systematically analyzing the heat data of the elemental substances, and will analyze the oxides, halides, and other compounds in succession. The results will be published in the NSRDS series.

#### Alloy Data Center

About a year ago the Alloy Data Center, NBS Institute for Materials Research, was formally initiated as an associated activity of the Office of Standard Reference Data.

This Center deals with properties grouped in the following categories: Electronic transport properties; magnetic properties; mechanical properties (e.g., densities, and also acoustical properties); nuclear and other resonance properties; quantum description of solids (Fermi surface work and band structure determination); electromagnetic radiation, with soft x-ray spectroscopy as a separate category; properties of superconducting materials; and thermodynamic properties. The materials of interest include all metals, binary alloys, and some higher order alloys.

The Center has a complete annotated bibliographic file on the soft x-ray literature.<sup>1</sup> At present it is compiling world-wide literature on nuclear magnetic resonance in metals and alloys for purposes of data evaluation. Evaluated data on Knight shifts will be the first publication.<sup>2</sup>

The Alloy Data Center was established for two reasons: First, to provide a coordination service to existing data centers so that final data generated by these centers will be consistent with one another where correlation or possible overlap exists. Second, to collect and evaluate data in those areas where special competence exists in the NBS Alloy Physics Section. Examples of this are the bibliography of soft x-ray literature and the compilation of Knight shift data.

Related data compilation groups include: The Binary Metal and Metalloid Constitution Alloys Data Center, IIT Research Institute, Chicago, Ill.; Thermodynamic Properties Data Center, University of California, Berkeley; Lattice Spacings and Structure Data Center, National Research Council, Ottawa, Canada; Superconducting Transition Temperatures Data Center, General Electric Corporation, Schenectady, N.Y.; Rare-Earth Information Center, Ames Laboratory, Iowa State University, Ames; Thermophysical Properties Research Center (TPRC), Purdue University, West Lafayette, Ind.; and the Cryogenic Data Center, National Bureau of Standards, Boulder, Colo.

#### Conference on Neutron Cross Sections and Technology

The Second Conference on Neutron Cross Sections and

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Technology will be held March 4-5, 1968, at the Shoreham Hotel, Washington, D.C., with D. T. Goldman, of the NBS Office of Standard Reference Data and the NBS Reactor Radiations Division, as chairman. The purpose of this Second Conference is to provide a common meeting area for the exchange of information among nuclear scientists and engineers interested in neutron cross sections. Contributed papers are encouraged in the following general topics:

1. The need for and use of neutron data in fields of basic and applied physics and reactor design,
2. Flux measurements and cross section standards,
3. The measurement and analysis of total and partial cross sections for fissile and nonfissile nuclei, including a presentation of the latest data,

4. The theory of nuclear cross sections and the analysis of neutron interactions,
5. Nuclear data storage, retrieval, and evaluation, and
6. Use of differential data in analyzing integral experiments.

Sessions will include both invited and contributed papers. Papers accepted for presentation will be published in the proceedings. Abstracts of contributions must be received by December 1, 1967, and should be sent to:

Dr. D. T. Goldman  
NBS Reactor Radiations Division  
Washington, D.C. 20234

<sup>1</sup> Annotated Bibliography on Soft X-Ray Spectroscopy, by H. Yakowitz and J. R. Cuthill, NBS Mono. 52, U.S. Government Printing Office, 1962. This compilation is being kept up to date by J. R. Cuthill and collaborators.

<sup>2</sup> L. H. Bennett and G. C. Carter (in press).

## PUBLICATIONS of the National Bureau of Standards\*

### PERIODICALS

*Technical News Bulletin*, Volume 51, No. 8, August 1967. 15 cents. Annual subscription: \$1.50. 75 cents additional for foreign mailing. Available on a 1-, 2-, or 3-year subscription basis.

*Journal of Research of the National Bureau of Standards*

*Section A. Physics and Chemistry*. Issued six times a year. Annual subscription: Domestic, \$5; foreign, \$6. Single copy, \$1.

*Section B. Mathematics and Mathematical Physics*. Issued quarterly. Annual subscription: Domestic, \$2.25; foreign, \$2.75. Single copy, 75 cents.

*Section C. Engineering and Instrumentation*. Issued quarterly. Annual subscription: Domestic, \$2.75; foreign, \$3.50. Single copy, 75 cents.

### CURRENT ISSUES OF THE JOURNAL OF RESEARCH

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*U.S. Government Research & Development Reports.* Semimonthly journal of abstracts of R & D reports on U.S. Government-sponsored projects and list of current projects. Annual subscription (24 issues): Domestic, \$30; foreign, \$37.50. Single copy, \$3.

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